# PATENT SPECIFICATION

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DRAWINGS ATTACHED

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## (54) A PROCESS FOR APPLYING A PROTECTIVE FILM TO UNSET PRINTING INK ON A SUBSTRATE

(71) I, FRANCIS STEPHEN ULRICH, of 2200 Carmelita Drive, San Carlos, California 94070, United States of America, a citizen of the United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a process of producing prints on a substrate, such as paper (inclusive of paper board) with an outer protective film of varnish which covers the unset ink and usually improves the gloss, and to a printed article produced by the process. More particularly, the invention is concerned with the protection of unset ink by a film of varnish whereby freshly printed material can be handled immediately without danger of smearing before the ink has set completely, thereby expediting handling and eliminating time delay. It is applicable to printing in a single color or in a plurality of colors, such as two to five. A specific application is the printing of multi-colored labels for cans and packages.

In conventional practice, printed material must be stacked and/or placed aside after passing from the lithographing or letterpress, and permitted to stand for some one to seven days, even after passage through a drying oven at a moderate temperature, e.g., 200-300°F., to permit drying of the ink before varnish can be applied to the printed material. Before the ink sets completely it can be smeared by handling or by frictional contact with machine parts. Also, varnishes commonly used contain hydrocarbon solvents which enter the ink vehicle when the latter is not fully set, causing blurring and other damage to the print.

It has heretofore been proposed to reduce or obviate this delay by using inks which are at least in part hydrophilic and applying to the unset ink varnishes which contain constituents which enter the unset ink to hasten setting. For example, according to U.S. patent No. 2,602,072, the varnish contains water that enters the ink vehicle to "flocculate" (more accurately, to precipitate) the pigment, and the coated material is dried in an oven. According to U.S. patent No. 2,974,058, an aqueous varnish is applied to freshly applied ink that is steam-settable, followed by heating to form steam and expel moisture. These proposals do not obviate the need to heat the substrate and have the drawback of requiring special printing inks.

Heating, whether used to hasten setting of the ink or to expel moisture from the varnish layer, must be held to moderately low temperatures to avoid damaging the substrate. When paper is heated to above 200-300°F. it shrinks to a variable degree and is deformed, variations being due to variations in the characteristics of the paper and the local temperatures attained during heating. Heating to higher temperatures aggravates shrinkage and makes most papers brittle. These often unpredictable consequences are deleterious to subsequent machine operations, such as cutting a continuous web or large sheets into individual labels and applying them to cans or packages.

Further, the entry of the solvent from the varnish into the ink vehicle is undesirable because it gives the printed material a flat appearance; the final product has less gloss and the colors are less uniform, often having a mottled appearance.

It has further been proposed to apply to the unset ink a varnish solution that contains a volatile solvent; see U.S. patent No. 2,696,168. However, the volatile solvents, such as alcohols and ethers, are obnoxious and create ventilation problems, and some degree of heating of the substrate to drive off the solvent is still necessary. Also, the solvents are at least partly miscible with the ink vehicle and enter it, to cause blurring or bleeding or the flat appearance noted above.

According to the present invention there is provided a process of producing a print on a substrate which includes the steps of applying to the substrate a layer of unset, hydrophobic printing ink that dries by essentially non-evaporative gellation of an ink vehicle,

applying directly to the freshly applied and unset layer of printing ink a layer of an aqueous solution of a water-soluble, film-forming varnish, and immediately thereafter subjecting the substrate bearing the unset ink and the wet layer of varnish solution to electromagnetic waves having a frequency between 0.3 and 3000 GHz. to evaporate the water.

Typical of printing inks suitable in this process are those in which the pigment is suspended in an ink vehicle consisting essentially of a drying oil, such as boiled linseed oil, although unboiled linseed oil inks can be used. Also typical are inks in which the vehicle consists essentially of a material that dries by polymerization, usually induced by heat, such as polyvinyl acetate, urea formaldehyde, and China wood oil. In some of these oxidation may play some part, particularly in alkyd resins. In all of these the ink dries by gellation, in which penetration of the paper usually contributes. When oxidation is the principal cause, sufficient oxygen to complete the setting process is present in the pores of the paper or moves into the layer of unset ink through the paper. Some setting may be initiated by the microwaves and/or by heat conducted from the water which is warmed by these waves. However, this does not complete setting and complete gellation of the ink vehicle occurs after the protective varnish film has become dry and the material is removed from the influence of the microwaves. Hence the printed substrate can be handled, e.g., cut and folded and even applied to the cans or packages before the ink is completely set without danger of smearing or otherwise damaging the print.

The particular merit of microwaves to dry the varnish is that these waves couple selectively to the water in the varnish solution to impart energy thereto and do not directly heat the paper or other substrate to a significant degree. Of course, some heating of the substrate and ink will result from heat flow from the vaporized water.

Microwaves have frequencies between 0.3 and 3000 GHz. ($3 \times 10^8$ to $3 \times 10^{12}$ cycles per second) and all effect vaporization of water to some extent. However, the highest frequencies transfer only little power, and it is, moreover, advantageous to use frequencies that coact or couple selectively with the water, to avoid as far as possible heating of the substrate and the ink. The natural resonant frequency of water is in the vicinity of 22 GHz., and for this reason it is preferred to use microwaves in the frequency range of 1 to 150 GHz. It may be further noted that the use of many specific frequency bands is regulated or forbidden by governmental bodies, such as, in the United States, the Federal Communications Commission. A specific frequency that is permitted and highly desirable is 2.45 GHz. However, the permitted frequencies of 5.8 and 22.5 GHz. can be used.

In this specification, the term "water-soluble" as applied to varnish, includes varnishes which are made water-soluble by the presence of a solubilizing agent. The solution of varnish used in this process is preferably concentrated and contains the least amount of water necessary to carry the varnish in solution without danger of precipitation. Preferably the solution contains from 40% to 75% by weight of water.

The varnishes are preferably resin varnishes made from such monomers as styrene and vinyl toluene or a member of the class consisting of urea formaldehyde and melamine formaldehyde. They may contain a plasticizing material made of a polyhydric alcohol, oil, or a fatty acid, and a minimal amount of a solubilizing agent such as carbitol can be included. Some ionic emulsifiers can be used to promote water solubility.

Specific examples of varnishes suitable are as follows; in both instances the resins are properly plasticized to form a water solution:

| | |
|---|---|
| *Resin A* | |
| Urea formaldehyde resin | 56.9% |
| Water | 44.0% |
| *Resin B* | |
| Melamine formaldehyde | 53.5% |
| Water | 46.5% |

The printed and varnish-coated material is exposed to the microwaves for a period not substantially greater than that required to expel the water, and the energy input will vary with the thickness of the varnish solution applied and its water content. Typically, 0.8 lbs. of resin per thousand square feet of backing material is applied, to form a varnish film which protects the ink, but this quantity is subject to considerable variation. About 50 KW hours are required to vaporize 150 lbs. of water.

Because of the hydrophobic nature of the printing ink, the varnish solution can be applied directly to the unset ink without bleeding, blurring or other undesirable effects. The application can be by a metallic, rubber or plastics material roller, which moves over the freshly printed surface in a non-wiping manner, or by other means, such as an air knife or a curtain coater. For example, the roller can be immersed in a pool of the varnish solution, or the solution can be transferred to the roller from another roller or doctor blade.

The varnish solution, having a water base, is less susceptible to fire and explosion than the commonly used varnishes which are applied dissolved in a volatile organic

solvent, such as a hydrocarbon, and does not emit obnoxious or toxic fumes.

The invention will be further described with reference to the accompanying drawing forming a part of this specification, wherein:

Figure 1 is a diagrammatic cross section of a layer of paper bearing the layers of printing ink and varnish;

Figure 2 is a diagrammatic elevation of the machine system for carrying out the process; and

Figure 3 is a diagrammatic plan of the microwave guide and parts thereof.

Referring to Figure 1, the product produced by subjecting printed and varnished backing material such as paper to microwaves according to the invention includes the backing material 5, a layer of at least partially unset printing ink 6 (which may include a plurality of sub-layers of different colors), and a dried layer or film of varnish 7. Although the layers are shown as having appreciable thickness, it will be understood that the thickness of the layer 6 is so small as to be barely discernible in an actual embodiment.

Referring to Figures 2 and 3, the feeder *A* delivers sheets *B* of substrate, such as paper, to a multi-color lithographing press *C*. Thus, the sheets *B* initially pass over a transfer cylinder 10, then under a transfer cylinder 11, over a first impression cylinder 12, and under a transfer cylinder 13. The press includes a plate cylinder 14 which receives a first color ink 15 from a vessel or fountain 16 by a series of rollers 17, and this ink is placed on the sheets *B* by a blanket cylinder 18 as they pass around the impression cylinder 12. The sheets thence pass over a second impression cylinder 19, on which they receive a second color ink 20 from a vessel or fountain 21 by a series of rollers 22, a plate cylinder 23 and a blanket cylinder 24. The printing operations can be repeated to apply any desired number of colors by adding units consisting of an ink vessel or fountain and the various rollers and cylinders as required. For simplicity the chains or other guides for advancing the sheets *B* are not shown.

Upon leaving the last impression cylinder 19, the sheets *B* are transferred to a gripper mechanism which includes endless belts or chains 25 and conveys the sheets to a varnishing machine *D*. Here the sheets, bearing wet printing ink, pass over an impression cylinder 26 and are coated with an aqueous solution of a water-soluble resin varnish by a varnish roller 27. The varnish solution 28 is transferred from a vessel or fountain 29 by a series of rolls 30 to the roller 27. The roller 27 may extend across the full width of the sheets *B*, or narrow strips on which no printing was done may be left uncoated with varnish, as by providing peripheral grooves in the roller 27 or preventing the transfer of the solution to the roller 27 at selected bands. This leaves longitudinal strips on the sheets which are blank and along which the sheets can later be cut and on which adhesive can be applied.

The wet sheets leaving the cylinder 26 are engaged by a gripper mechanism which includes belts or chains 31 and carried to a microwave drying machine *E*. This machine includes a series of wave guides 32, 33, 34 which may be traverses of a continuous wave guide connected by 180° bends 35. Although only three traverses are shown, it is evident that a greater number may be used, and that the machine may include more than one such units. The wave guide is connected by a flexible guide 36 to a wave generator 37, such as a magnetron or klystron, which generates microwaves of the desired frequency and is supplied with power from a power pack 38. The power pack is energized from a circuit 39. The end of the wave guide is preferably terminated in a water load 40, e.g., a body of water isolated from the wave guide by a diaphragm.

Each of the wave guides 32, 33 and 34 has a pair of narrow slots at its sides and the sheets *B* are moved continuously through the wave guides by these slots and absorb energy to vaporize water from the varnish solution and dry the varnish into a film. The water load acts as a sink to absorb the energy of the microwaves when the sheets *B* are absent (as occurs momentarily between sheets) or are too dry to absorb the normal power from the generator 37. The microwave drying machine *E* is known *per se* and is, therefore, not described in detail.

It is desirable to avoid passing a metallic chain or metallic grippers through the wave guides. Non-metallic gripping and forwarding elements may be used. In the example, the sheets *B* are shown to be transferred from the mechanism 31 to an endless belt 41 which may be hollow and operated under suction, provided from a suction device 42. This suction holds the sheets to the belt 41, which pulls the sheets through the successive wave guides 32, 33 and 34.

Upon leaving the wave guides the sheets are released from the belt 41 by a suitable suction-breaking element 43 over a delivery receptacle *F*. The sheets are stacked as appears at *G*. Because the details of the elements for applying and breaking the suction are not a part of this invention, they are not shown.

Because the varnish film 7 is dried in the microwave guides, the at least partially unset ink 6 is protected and the sheets *G* can be stacked, restacked, cut, folded, or otherwise manipulated immediately without bleeding, sticking, offsetting, or smearing of the ink. The ink dries thereafter, usually in a period of one to seven days.

It is evident that numerous modifications may be made in the system sh wn in Figures 2 and 3. For example, the sheets *B* can be moved through the microwave guides more slowly than through the press and varnishing machine by providing two or more separate drying paths, permitting every second or every third sheet to follow one path. Devices for directing successive sheets into different courses being well known, so no description thereof is presented. Also, instead of individual sheets *B*, the process is applicable to printing a continuous sheet or web.

WHAT I CLAIM IS:—

1. A process of producing a print on a substrate, which includes the steps of applying to the substrate a layer of unset, hydrophobic printing ink that dries by essentially non-evaporative gellation of an ink vehicle, applying directly to the freshly applied and unset layer of printing ink a layer of an aqueous solution of a water-soluble, film-forming varnish, and immediately thereafter subjecting the substrate bearing the unset ink and the wet layer of varnish solution to electromagnetic waves having a frequency between 0.3 and 3000 GHz.

2. Process as claimed in claim 1 wherein the waves have a frequency between 1 and 150 GHz.

3. Process as claimed in claim 1 wherein the aqueous solution contains between 40% and 75% by weight of water and the varnish is a water-soluble synthetic resin varnish.

4. Process as claimed in claim 3 wherein the varnish is a formaldehyde resin which is a member of the class consisting of urea formaldehyde and melamine formaldehyde resins.

5. Process as claimed in claim 1 wherein the substrate is paper and the printing ink vehicle dries principally by oxidation.

6. Process as claimed in claim 5 wherein the ink vehicle is boiled linseed oil.

7. Process as claimed in claim 1 wherein the substrate is paper and the ink vehicle consists principally of an alkyd resin.

8. Process as claimed in claim 1 wherein the substrate is paper and the printing ink vehicle dries principally by polymerization.

9. A printed article comprising a substrate, a layer of at least partially unset, hydrophobic ink on said substrate, said ink having a vehicle that dries by essentially non-evaporative gellation of the vehicle, and a layer of a dry, protective varnish covering the ink layer.

10. An article as claimed in claim 9 wherein said substrate is paper.

11. A printed article as claimed in claim 9, said printed article being made by the process claimed in claim 1.

12. A printed article as claimed in claim 11, wherein said substrate is paper.

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1261329 COMPLETE SPECIFICATION

1 SHEET

*This drawing is a reproduction of the Original on a reduced scale*

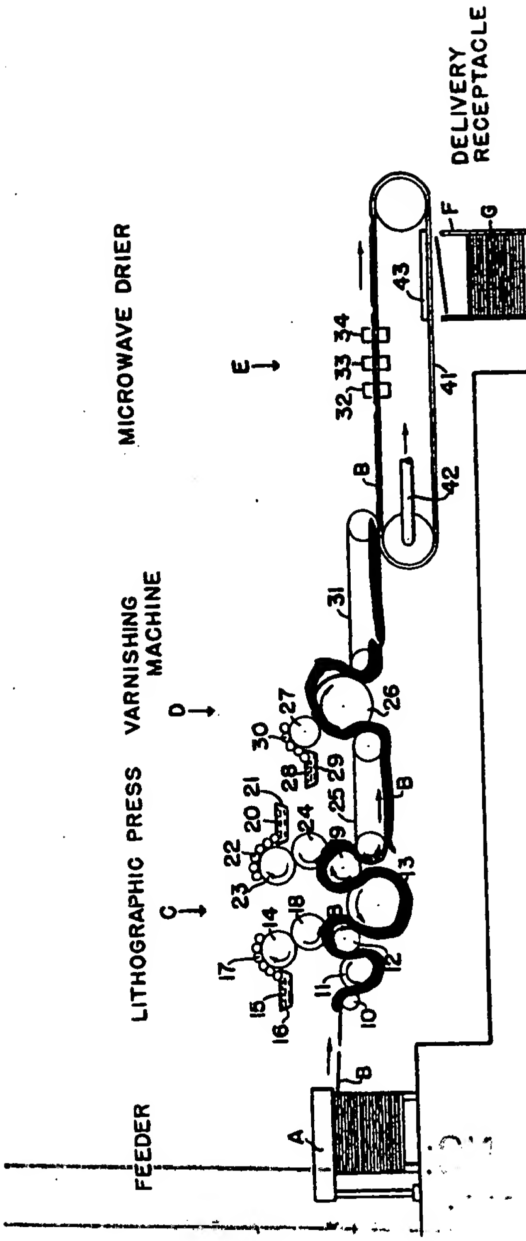


FIG. 2

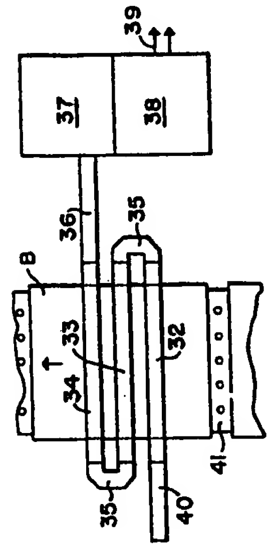


FIG. 3

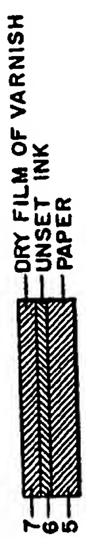


FIG. 1

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